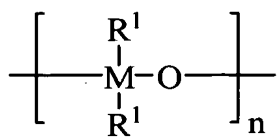
We Claim:

1. A composition useful for forming solid-state device structures, said composition comprising:

a solvent system;

an organometallic oligomer dissolved or dispersed in said solvent system, said organometallic oligomer comprising recurring monomers having the formula



,

wherein:

n is greater than 2;

each M is individually selected from the group consisting of Groups 3-5 and 13-15 metals other than silicon and having a combining valence of greater than +2; and

each R^1 is an organic moiety covalently bonded or coordinate-covalently bonded to M; and

an organic polymer or oligomer having a weight-average molecular weight of at least about 150 g/mol, said organic polymer or oligomer comprising a functional group operable to form a covalent or coordinate-covalent bond with said organometallic oligomer.

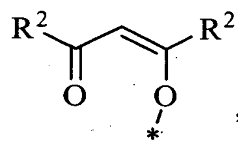
2. The composition of claim 1, wherein M is selected from the group consisting of Group 4 metals.

3. The composition of claim 1, wherein M is selected from the group consisting of titanium and zirconium.

4. The composition of claim 1, wherein n is 3-10.

5. The composition of claim 1, wherein each R^1 is individually selected from the group consisting of alkoxys, alkyloxyalkoxys, beta-diketones, beta-diketonates, and alkanolamines.

6. The composition of claim 5, wherein R^1 has a formula selected from the group consisting of

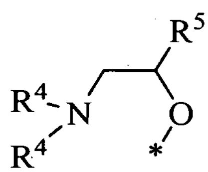


, (I)

wherein:

* represents the covalent bond or coordinate covalent bond with M; and

each R^2 is individually selected from the group consisting of alkyls, haloalkyls, and $-OR^3$, wherein R^3 is selected from the group consisting of hydrogen, alkyls, aryls, and alkylaryls; and



, (II)

wherein:

* represents the covalent bond or coordinate covalent bond with M;

each R^4 is individually selected from the group consisting of hydrogen, alkyls, hydroxyalkyls, aryls, and alkylaryls, with at least one R^4 being selected from the group consisting of hydrogen, alkyls, and hydroxyalkyls; and

R^5 is selected from the group consisting of hydrogen and methyl.

7. The composition of claim 6, wherein each R^4 is individually selected from the group consisting of 2-hydroxyethyl and 2-hydroxypropyl.

8. The composition of claim 7, wherein each R^4 forms coordinate-covalent bonds with at least one metal atom.

9. The composition of claim 1, wherein said organometallic oligomer comprises poly(dibutyltitanate) reacted with ethyl acetoacetate.

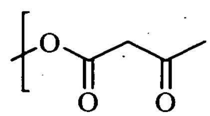
10. The composition of claim 1, wherein said organic polymer or oligomer has a polymer backbone, and said functional group forms a part of said polymer backbone.

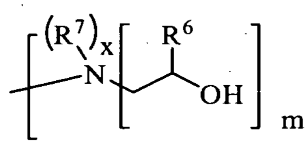
11. The composition of claim 1, wherein said organic polymer or oligomer has a polymer backbone, and said functional group is pendantly attached to said polymer backbone.

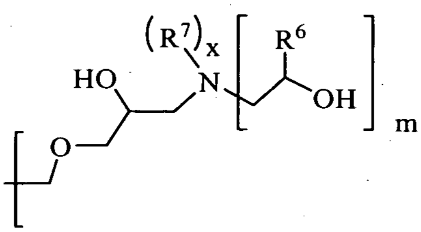
12. The composition of claim 11, wherein said functional group is pendantly attached to said polymer backbone via a linking group intermediate said polymer backbone and said functional group.

13. The composition of claim 1, wherein said functional group is selected from the group consisting of -OH, -SH, and chelating moieties.

14. The composition of claim 13, wherein said functional group is a chelating moiety selected from the group consisting of


, (III)


, and (IV)


, (V)

wherein:

m is 1 or 2;

when m is 2, then x is 0;

each R^6 is individually selected from the group consisting of hydrogen and methyl groups; and

each R^7 is individually selected from the group consisting of hydrogen and alkyls.

15. The composition of claim 1, wherein said organic polymer or oligomer is selected from the group consisting of poly(styrene-co-allyl alcohol), poly(ethylene glycol), glycerol ethoxylate, pentaerythritol ethoxylate, pentaerythritol propoxylate, and combinations thereof.

16. The composition of claim 1, wherein said composition can be heated to a temperature of at least about 150°C for at least about 3 minutes to yield a metal oxide film having a refractive index of at least about 1.65 at a wavelength of about 633 nm and at a film thickness of about 0.5 μm.

17. The composition of claim 1, wherein said composition can be heated to a temperature of at least about 150°C for at least about 3 minutes to yield a metal oxide film having a percent transmittance of at least about 80% at a wavelength of about 633 nm and at a film thickness of about 0.5 μm.

18. The composition of claim 1, wherein said composition can be heated to a temperature of at least about 150°C for at least about 3 minutes to yield a metal oxide film having a metal oxide content of from about 25-80% by weight, based upon the total weight of the metal oxide film taken as 100% by weight.

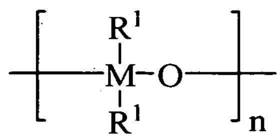
19. The combination of:

a substrate having a surface; and

a layer of a composition on said substrate surface, said composition comprising:

a solvent system;

an organometallic oligomer dissolved or dispersed in said solvent system, said organometallic oligomer comprising recurring monomers having the formula

 ,

wherein:

n is greater than 2;

each M is individually selected from the group consisting of Groups 3-5 and 13-15 metals other than silicon and having a combining valence of greater than +2; and

each R^1 is an organic moiety covalently bonded or coordinate-covalently bonded to M; and

an organic polymer or oligomer having a weight-average molecular weight of at least about 150 g/mol, said organic polymer or oligomer comprising a functional group operable to form a covalent or coordinate-covalent bond with said organometallic oligomer.

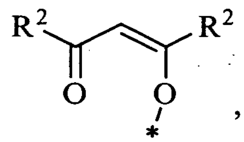
20. The combination of claim 19, wherein M is selected from the group consisting of Group 4 metals.

21. The combination of claim 19, wherein M is selected from the group consisting of titanium and zirconium.

22. The combination of claim 19, wherein n is 3-10.

23. The combination of claim 19, wherein each R^1 is individually selected from the group consisting of alkoxys, alkyloxyalkoxys, beta-diketones, beta-diketonates, and alkanolamines.

24. The combination of claim 23, wherein R^1 has a formula selected from the group consisting of

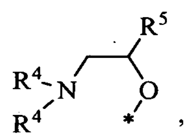


(I)

wherein:

* represents the covalent bond or coordinate covalent bond with M; and

each R^2 is individually selected from the group consisting of alkyls, haloalkyls, and $-OR^3$, wherein R^3 is selected from the group consisting of hydrogen, alkyls, aryls, and alkylaryls; and



(II)

wherein:

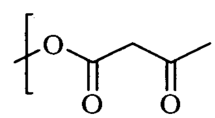
* represents the covalent bond or coordinate covalent bond with M;

each R^4 is individually selected from the group consisting of hydrogen, alkyls, hydroxyalkyls, aryls, and alkylaryls, with at least one R^4 being selected from the group consisting of hydrogen, alkyls, and hydroxyalkyls; and

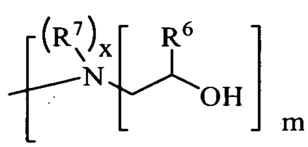
R^5 is selected from the group consisting of hydrogen and methyl.

25. The combination of claim 19, wherein said functional group is selected from the group consisting of -OH, -SH, and chelating moieties.

26. The combination of claim 25, wherein said functional group is a chelating moiety selected from the group consisting of



, (III)



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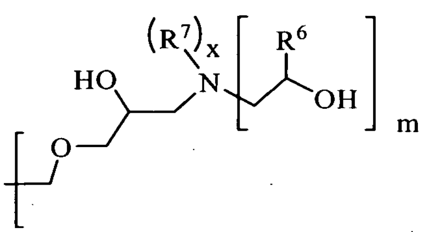


, (V)

wherein:

m is 1 or 2;

when m is 2, then x is 0;

each R^6 is individually selected from the group consisting of hydrogen and methyl groups; and

each R^7 is individually selected from the group consisting of hydrogen and alkyls.

27. The combination of claim 19, wherein said organic polymer or oligomer is selected from the group consisting of poly(styrene-co-allyl alcohol), poly(ethylene glycol), glycerol ethoxylate, pentaerythritol ethoxylate, pentaerythritol propoxylate, and combinations thereof.

28. The combination of claim 19, wherein said layer can be heated to a temperature of at least about 150°C for at least about 3 minutes to yield a metal oxide film having a refractive index of at least about 1.65 at a wavelength of about 633 nm and at a film thickness of about 0.5 μm.

29. The combination of claim 19, wherein said layer can be heated to a temperature of at least about 150°C for at least about 3 minutes to yield a metal oxide film having a percent transmittance of at least about 80% at a wavelength of about 633 nm and at a film thickness of about 0.5 μm.

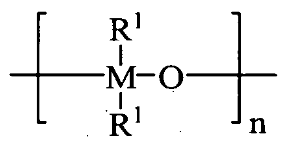
30. The combination of claim 19, wherein said layer can be heated to a temperature of at least about 150°C for at least about 3 minutes to yield a metal oxide film having a metal oxide content of from about 25-80% by weight, based upon the total weight of the metal oxide film taken as 100% by weight.

31. The combination of claim 19, wherein said substrate is selected from the group consisting of flat panel displays, optical sensors, integrated optical circuits, and light-emitting diodes.

32. A method of forming a solid-state device structure, said method comprising the step of applying a composition to a substrate surface to form a layer of said composition on said substrate surface, said composition comprising:

a solvent system;

an organometallic oligomer dissolved or dispersed in said solvent system, said organometallic oligomer comprising recurring monomers having the formula



,

wherein:

n is greater than 2;

each M is individually selected from the group consisting of Groups 3-5 and 13-15 metals other than silicon and having a combining valence of greater than +2; and

each R^1 is an organic moiety covalently bonded or coordinate-covalently bonded to M; and

an organic polymer or oligomer having a weight-average molecular weight of at least about 150 g/mol, said organic polymer or oligomer comprising a functional group operable to form a covalent or coordinate-covalent bond with said organometallic oligomer.

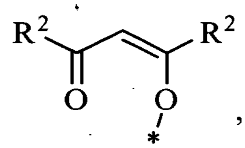
33. The method of claim 32, wherein M is selected from the group consisting of Group 4 metals.

34. The method of claim 32, wherein M is selected from the group consisting of titanium and zirconium.

35. The method of claim 32, wherein n is 3-10.

36. The method of claim 32, wherein each R^1 is individually selected from the group consisting of alkoxys, alkyloxyalkoxys, beta-diketones, beta-diketonates, and alkanolamines.

37. The method of claim 36, wherein R^1 has a formula selected from the group consisting of

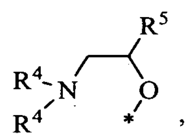


(I)

wherein:

* represents the covalent bond or coordinate covalent bond with M; and

each R^2 is individually selected from the group consisting of alkyls, haloalkyls, and -OR^3, wherein R^3 is selected from the group consisting of hydrogen, alkyls, aryls, and alkylaryls; and



(II)

wherein:

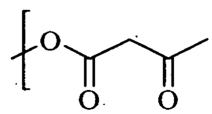
* represents the covalent bond or coordinate covalent bond with M;

each R^4 is individually selected from the group consisting of hydrogen, alkyls, hydroxyalkyls, aryls, and arylalkyls, with at least one R^4 being selected from the group consisting of hydrogen, alkyls, and hydroxyalkyls; and

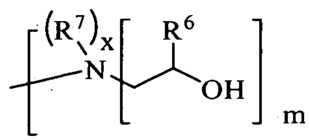
R^5 is selected from the group consisting of hydrogen and methyl.

38. The method of claim 32, wherein said functional group is selected from the group consisting of -OH, -SH, and chelating moieties.

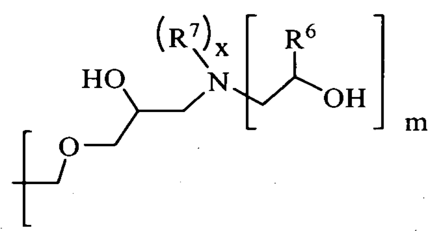
39. The method of claim 38, wherein said functional group is a chelating moiety selected from the group consisting of



, (III)



, and (IV)



, (V)

wherein:

m is 1 or 2;

when m is 2, then x is 0;

each R^6 is individually selected from the group consisting of hydrogen and methyl groups; and

each R^7 is individually selected from the group consisting of hydrogen and alkyls.

40. The method of claim 32, wherein said organic polymer or oligomer is selected from the group consisting of poly(styrene-co-allyl alcohol), poly(ethylene glycol), glycerol ethoxylate, pentaerythritol ethoxylate, pentaerythritol propoxylate, and combinations thereof.

41. The method of claim 32, wherein said substrate is selected from the group consisting of flat panel displays, optical sensors, integrated optical circuits, and light-emitting diodes.

42. The method of claim 32, further comprising the step of heating said composition to a temperature of at least about 150°C for at least about 3 minutes to yield a metal oxide film.

43. The method of claim 42, wherein said metal oxide film has a refractive index of at least about 1.65 at a wavelength of about 633 nm and at a film thickness of about 0.5 μm.

44. The method of claim 42, wherein said metal oxide film has a metal oxide content of from about 25-80% by weight, based upon the total weight of the metal oxide film taken as 100% by weight.

45. The method of claim 42, wherein said metal oxide film has a thickness of greater than about 1 μm and is free of cracks when observed under a microscope at a magnification of 200X.

46. The method of claim 42, further comprising the step of preheating said composition prior to said heating step, said preheating step comprising heating said composition to a temperature of less than about 130°C for a time of from about 1-10 minutes.

47. The method of claim 42, wherein said metal oxide film has a percent transmittance of at least about 80% at a wavelengths of about 600 nm and at a film thickness of about 0.5 μm.

48. A method of forming a composition for use in forming solid-state device structures, said method comprising the steps of dispersing or dissolving an organometallic polymer and an organic polymer or oligomer in a solvent system,

said organometallic polymer comprising recurring monomers having the formula

$$\left[\begin{array}{c} R^1 \\ | \\ -M-O- \\ | \\ R^1 \end{array} \right]_n ,$$

wherein:

n is greater than 2;

each M is individually selected from the group consisting of Groups 3-5 and 13-15 metals other than silicon and having a combining valence of greater than +2; and

each R^1 is an organic moiety covalently bonded or coordinate-covalently bonded to M; and

said organic polymer or oligomer comprising a functional group operable to form a covalent or coordinate-covalent bond with said organometallic oligomer and having a weight-average molecular weight of at least about 150 g/mol.

49. The method of claim 48, wherein said dissolving or dispersing step comprises dissolving or dispersing said organometallic polymer and said organic polymer or oligomer in separate solvent systems to yield an organometallic polymer dispersion and an organic polymer or oligomer dispersion, said method further comprising the step of combining said organometallic polymer dispersion and said organic polymer or oligomer dispersion to yield the composition.

50. The method of claim 48, wherein said dissolving or dispersing step comprises dissolving or dispersing said organometallic polymer and said organic polymer or oligomer in the same solvent system.

51. The method of claim 48, further comprising the step of forming said organometallic oligomer by reacting a metal oxide precursor with a chelating agent prior to said dispersing or dissolving step.